# MINI-BRUTE
# DIFFUSION FURNACE

## MODEL MB-80

THERMCO

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THERMCO

Specification Number 15100

## "MINI-BRUTE" - 80

ONE THERMCO Bench Model Diffusion Furnace Assembly, Single Chamber, Type MB-80, complete with the following specifications:

## P E R F O R M A N C E

1. Uniform Heated Zone . . . . between 800° and 1300°C.
   Process tubes up to 6" (152.4 mm) O.D.

   10" - 14" (30.48 cm - 35.56 cm) ± ½°C
   12" - 16" (35.56 cm - 40.64 cm) ± 1°C

   Uniform Heated Zone . . . . between 400° and 800°C.
   Process tubes up to 6" (152.4 mm) O.D.

   10" - 12" (25.4 cm - 30.48 cm) ± 1°C
   12" - 14" (30.48 cm - 35.56 cm) ± 2°C

2. Maximum Sensitivity . . . . furnace will reach maximum operating temperature 75 minutes or less after a cold start regardless of tube size. Furnace will cool from 1200° - 500°C with a linear program rate of at least 3°C per minute.

3. Stability . . . . furnace temperature will remain stable within ± ¼°C.

4. Operating Temperature Range . . . . 400° - 1300°C (dependent upon tube size).

## C O N T R O L  S Y S T E M

1. THERMCO Ana-Lock Series 321 . . . . three-zone computerized controller, all solid state employing FET choppers.

2. Digital Dialing . . . . end zone range ± 50°C settable in 1/10°C increments. Center zone range 400° - 1400°C easily settable within ½°C increments.

3. High Sensitivity . . . . fully adjustable ½° - 10°C proportional band with automatic reset for all three zones. Temperature deviations of 1/200°C can be sensed and corrected.

4. Prebaked and Dynamically Checked . . . . components insure high reliability and stable operation. Long term stability of ± 1 microvolt or less for seven days under constant operating conditions.

5. Thermocouple Burn-Out Protection . . . . reduced input power to minimum to prevent destruction of the heating element in the event of an open thermocouple.

6. Redundant Three-Zone Overheat Protection . . . . shuts off heating element power in case of component failure.

## GENERAL

1. The "Mini-Brute" features minimum space requirements. Physical dimensions are 31.50" (80.01 cm) wide x 40" (101.6 cm) long x 17.31" (43.9674 cm) high. Units are designed for easy stacking to form multiple chamber assemblies.

2. Cooling System Flexibility . . . . furnace can be operated using air cooling or water cooling. Silent running exhaust fans and air to water heat exchanger are provided as standard equipment.

3. Replaceable cartridge heating assembly employs selective combinations of low heat capacity, ultra high purity materials. Design permits rapid replacement even while hot.

4. Iron Chromium Aluminum Rod Heating Element . . . . three zone, No. 2 gauge (0.258"0) (0.65532 cm). Element spacing and tube support provided with patented, lightweight, high purity refractory combs.

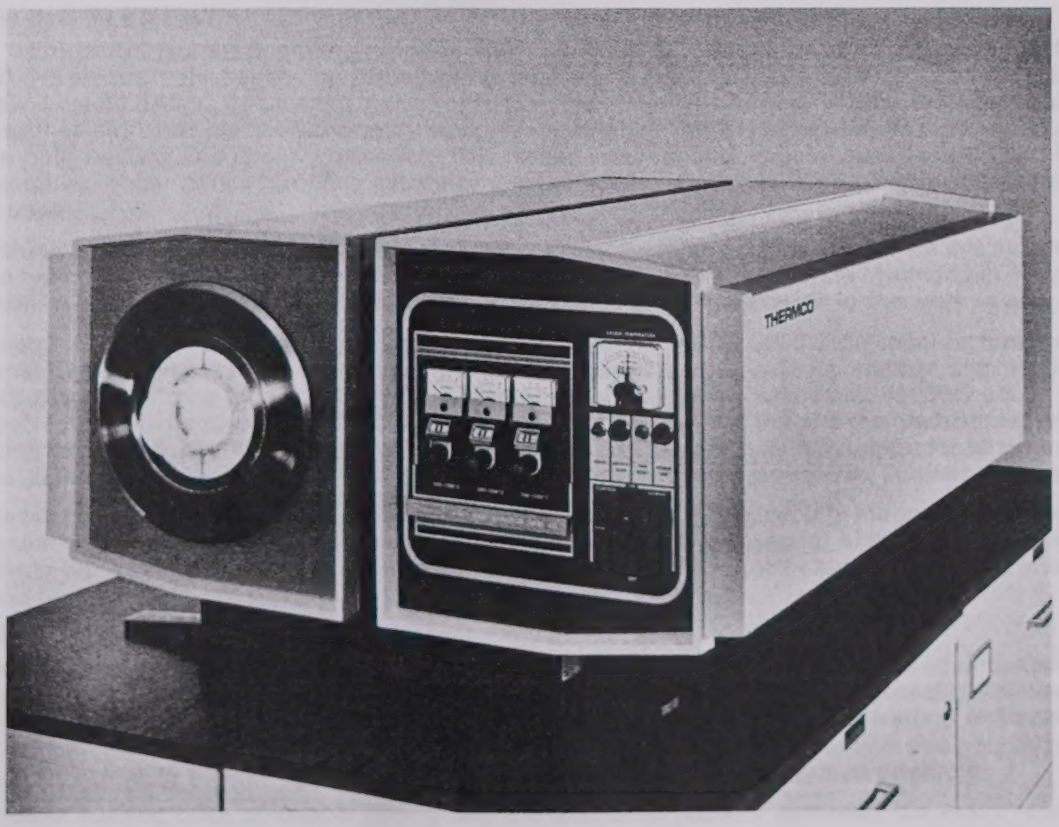
5. Long Life Thermocouples . . . . manufactured of reference grade platinum/platinum 13% rhodium wire with high purity alumina insulators.

6. Secondary Operated SCR Controllers . . . . for maximum reliability. Minimum radio frequency interference (RFI) by use of zero crossover SCR firing circuit. Conservatively rated high overload devices with forced convection cooling prevents thermal runaway.

7. Process Tubes . . . . up to 6" (152.4 mm) O.D. can be accommodated. Unique element design with built-in supporting pins eliminates the need for liner tubes or support pieces.

8. Units are readily stackable.

9. Designed for operation on 208/220/240 volts, single phase, 50/60 Hz. power service. Power input, 10 KW.



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# THERMCO TECHNICAL BULLETIN

## "MINI-BRUTE" MB-80

The "Mini-Brute" MB-80 bench model furnace is totally unlike other equipment available anywhere in the industry today, because it permits the same adherence to critical operating requirements, and furnishes the quality features that have heretofore been possible only with high priced diffusion furnaces. At the same time the "Mini-Brute" offers compact design, flexibility, portability, and all of the conveniences of laboratory furnaces. This furnace utilizes the same control system and element design furnished in Thermco diffusion furnaces which process extremely critical material for the semiconductor and microelectronics industry.

The "Mini-Brute," therefore, is intended to reach that distinct segment of the thermal processing market that requires sophisticated control, durability, serviceability, and performance, all at a reasonable price. It is not designed to compete across the board with low priced, marginally performing equipment typical of some portions of the laboratory market. The features offered, and how they differ from some of the existing bench furnaces on the market are explored herein for the Thermco Model MB-80 furnace.

### PERFORMANCE

A uniform heated flat zone of 14 inches, or greater, at ±1/2° C with 3 1/4" O.D. process tubes, is obtainable with the standard "Mini-Brute" furnace. The furnace can operate with tubes up to 6" O.D., at slightly shorter, 10" flat zone, again at ±1/2° C.

The "Mini-Brute" displays maximum sensitivity and will reach maximum operating temperatures 75 minutes or less after a cold start regardless of tube size. Furnace will cool from 1200° C to 500° C with a linear program rate of at least 3° C per minute. Stability of furnace temperature is within ±1/4° C over long term operation, especially important for long cycle work. Repeatability is as exacting as stability.

### HEATING ELEMENT

The "Mini-Brute" has an operating range of 400° C to 1300° C. The temperature range of 400° C through 1300° C is unique in the bench type, tube furnace field, and is possible in the "Mini-Brute" only because of its unique element design. Because of the use of all fiber insulation, the furnace is responsive to a much greater degree than any other piece of laboratory equipment available. There is absolutely no brick in the unit to slow down both heating and cooling response. This means less lost time, greater speed in bringing furnace to temperature, better critical profiling capability and the ability to program both positive and negative cycles with ease.

Additionally, the entire heating element assembly is removable and replaceable since it is a cartridge unit, again typical of high quality, diffusion furnace cannisters. All materials used are of a high purity, low sodium content, to reduce to an absolute minimum the possibility of contamination to the work in process.

The heating element itself is a three zone, continuously wound helical coil design, manufactured of #2 gauge Kanthal A1 wire (nickel-chrome-aluminum) mounted in low K factor insulating material and held in place by the exclusive Thermco high purity alumina element spacer combs. The combs not only afford necessary support for the element, which contributes greatly to long element life, but also maintain proper element coil spacing for uniform heating. Of equal importance, the combs provide positive support for *all* sizes of process tubes, eliminating the need for ceramic liner tubes, or hearth supports required in other designs.

Close temperature control, ±1/2° C, with tubes up to 6" O.D. is possible through the combination of the 6 3/4" diameter element and low heat content vestibule blocks, which are cast of highest purity materials. The vestibule blocks tailored directly to process tube size, also are a major factor in minimizing end radiation losses.

### WATER COOLING

Since the "Mini-Brute" furnace is designed for use in precision laboratory work, it is equipped with a water cooled heating chamber, as a standard feature. This helps keep the lab environment cool and prevents adding additional loading onto the plant air conditioning facility. Water cooling the heating chamber removes approximately 60% of the BTU required to operate the unit which would otherwise dissipate into the room. This is an exclusive feature found only on the "Mini-Brute" and other Thermco products.

The water cooling coils of copper tubing and the aluminum radiator assembly are easily removable for cleaning or replacement without dismantling the heating chamber itself. If cooling water is not available, the equipment functions to the same performance levels as without the water cooling feature. The unit is merely run without connecting the cooling system.

In addition to the water cooling coils, both the heating chamber and the power control console are air cooled via silent running, high volume circulating fans, which draw in room air to keep all components running trouble free even at continuous operation at the maximum temperature rating.

## CONTROLS

The heart of the "Mini-Brute" furnace is its highly sophisticated control system, which is identical to that used in Thermco's diffusion furnaces, and which provides the same degree of sensitivity, stability, accuracy, and settability commonly required for the highly critical diffusion processes.

The 3 zone, master slave Ana-Lock Controller, Series 321, is 100% solid state, using FET choppers, each zone having full proportional control, and automatic reset.

All components are prebaked and dynamically checked insuring high reliability and stable operation. Long term stability of ±1° microvolt or less for seven days under constant operating conditions is specified for the "Mini-Brute." High sensitivity is coupled to the fully adjustable proportional band with automatic reset for all three zones. Temperature deviations of 1/200° C can be sensed and corrected.

A characterized potentiometer digital setpoint unit, is furnished for accuracy, and so that actual control temperatures coincide closely with digital setpoint readings. Center zone range of 400° C to 1400° C can be set to within 1/2° C increments. The end zone range of ±50° C is settable in 1/10° increments.

A salient feature of the Ana-Lock control is its employment of printed circuit cards for each modular function of the unit. The use of printed circuit boards and thoroughly tested components, make the Ana-Lock Controller virtually maintenance free. Troubleshooting or replacing a defective component or board becomes a purely routine matter. Downtime is therefore vitually eliminated.

Deviation meters are supplied on each zone for ease of profiling, and rapid checking of operating conditions.

## EXCESS TEMPERATURE

A fully redundant excess temperature cutout system is furnished as standard, sensing temperature in all 3 zones of control, and using a direct reading meter for visual temperature confirmation. A single relay meter system is employed using a compensating calibration potentiometer and T/C placed in all three zones of the furnace. This digital setpoint potentiometer is adjustable to balance or shunt out the millivoltage of the end zone excess temperature thermocouples. In the event the furnace operating temperature rises above the preset alarm temperature, both an audio and visual alarm will actuate and power is automatically removed from the heating element.

In addition, thermocouple burnout protection is provided and reduces input power to minimum to prevent destruction of the heating element in event of an open thermocouple.

Many competitive controls rely on non-redundant excess temperature safeties; which, since they are part of the controller itself, cannot afford full protection against all instrument malfunctions.

## POWER CONTROLS

Zero crossover, secondary fired SCR's are standard and employed on each zone of control. Again, this is a major deviation from typical, competitive equipment, which normally employs contactors, or at best saturable core reactors or triac power supplies. The Thermco SCR package affords the best method of controlling power that is available in the power monitoring field today.

Zero crossover SCR's are particularly mandatory in laboratory areas where RFI (Radio Frequency Interference) could be detrimental to sensitive apparatus or test equipment. Additionally, locating the SCR's in the secondary circuit of the transformer, protects them from voltage spikes and irregularities that could result in serious damage in primary mounted units. These units are conservatively rated as high overload devices, with forced convection cooling, to prevent thermal runaway. All components are 100% duty rated to insure long and trouble free life.

## DESIGN APPEARANCE

Taking the last logical step in furnishing a completely quality piece of equipment; we have packaged all of these very functional features, that result in engineering and production advantages, in an integral assembly which is highly pleasant esthetically. The overall quality of packaging reflects, we think, the quality that we have built into the equipment.

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# BRIEF INSTALLATION AND START-UP PROCEDURE FOR MINI-BRUTE

NOTE: Make certain that all Circuit Breakers (one on the rear and two on the front) are OFF.

## I. Facility Connections

Power Requirements: 208/220/240, single phase (7.25 KVA, 35 Amp).

NOTE: The Power Transformer will be tapped at the factory for one of the following voltages: 208/220/240, and the Power Input Lead will be so marked. If you should desire a voltage other than that chosen by the factory, you can select your desired voltage off of the Power Transformer. The Taps are clearly labeled.

Water Requirements: Supply Line should allow a flow of .75 to 1 GPM, and care should be taken not to exceed 40 PSI in water line pressure. Also, if a Closed Recovery System is used, make certain that the back pressure is regulated well below the input pressure.

NOTE: Do not insert the Process Tube or Liner (if used) until you have completed Part III. Do, however, pack the Vestibule Block Assemblies.

## II. Packing

During installation of the Process Tube (and/or Liner Tube) into the Heating Chamber, packing material (insulating Fibre-Fax, Kaowool, or equivalent) must be packed between the Tube and the Vestibule Block as a heat sealing mechanism. Packing should be carefully and evenly placed to thoroughly seal these loose pieces against heat leakage from the Chamber ends.



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## BRIEF INSTALLATION AND START-UP

## PROCEDURE FOR MINI-BRUTE
(Continued)

Without anything in the Furnace (Quartz Tube or Liner), loosely pack both ends of the Furnace with Fibre-frax, Kaowool, or equivalent. Then throw the Circuit Breaker located on the rear of the Furnace. This will cause the Cooling Fans to operate across the Heating Chamber and the SCR Silo.

Now, turn on the front Breaker marked "Control". This will cause all the Power Meters to peg at 100% momentarily, then return to zero. It will take the Controller a minute or so to re-set. Set the controls as follows: 500, 100, 500. When the Controller has re-set, the center Power Input Meter will be pegged at 100%. (NOTE: End zones can be in either position). Turn on the Element Breaker and the Power-On Light will come on.

To test the Excess Temperature System, turn the Excess Temperature Meter down until it crosses the Temperature Indicator. This will cause the Element Power Breaker to be tripped, Excess Temperature Light to come on, and an Audible Alarm to sound. Reset the Excess Temperature Meter to 800°C., then press the Alarm Re-set. This will silence the Alarm and cause temperature indicating needle to drop to the actual temperature of the Furnace. Next, throw the Element Breaker on. Furnace will continue to rise in temperature until the Setpoints are reached. Once the temperature is reached, the Power Output Meters will start to cycle and then stabilize at a fairly constant reading. Now turn the center Setpoint up to 500 and increase the excess temperature setting to 1000°C. Let the Furnace run at this setting for one or two work days. This will ensure a uniform oxide coating on the Element and will give assurance of better Profile and longer Element life. (NOTE: It is normal for the insulation binder material and Vestibule Block Assemblies to outgas slightly during the initial turn-on and is not a cause for concern.



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BRIEF INSTALLATION AND START-UP

PROCEDURE FOR MINI-BRUTE
(Continued)

After this process is done, complete Part II with regard to Process Tube and Liner (if used) packing. Furnace is now ready for your use.



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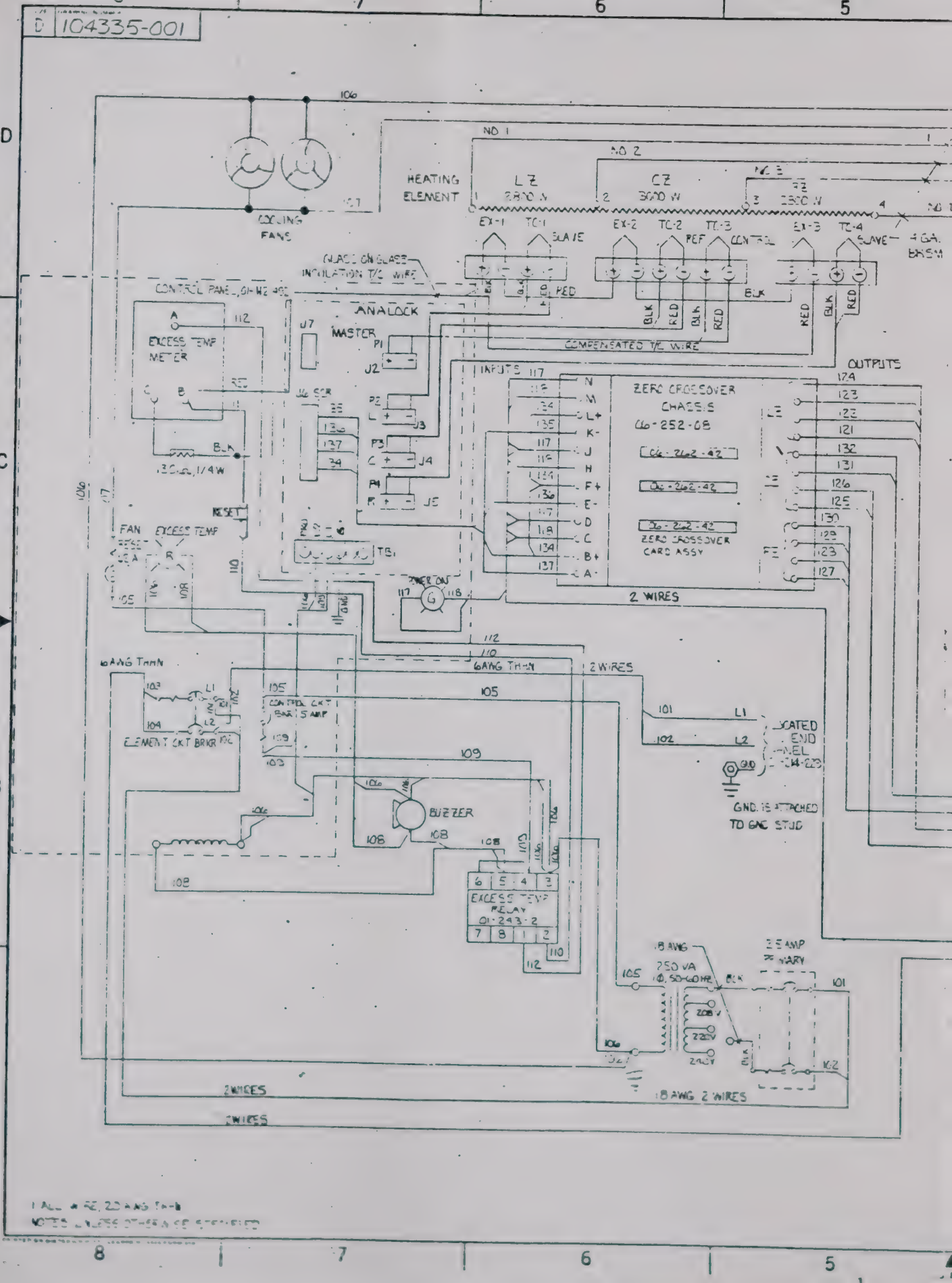
# RECOMMENDED SPARE PARTS LIST

## Mini-Brute Single Chamber Diffusion Furnace
## Model MB-80

| SUGGESTED QUANTITY | PART NUMBER | DESCRIPTION |
|---|---|---|
| 1 | HC-391 | 01-102-1175 Element Chamber Assembly |
| 1 Set (2/Set) | 01-405-95 | Vestibule Block |
| 3 | 01-415-175 | Double Thermocouple Assembly |
| 1 | 01-415-194 | Single Thermocouple Assembly |
| 3 | C52BX476 | SCR Device, Flag Type |
| 1 | 01-243-2 | Excess Temperature Power Supply |
| 3 | 06-262-42 | Zero Crossover Firing Card |
| 1 | 06-262-05 | Power Supply Card |
| 1 | 06-262-12 | Clock Card |
| 3 | 06-262-06 | Op-Amp Card |
| 2 | 06-262-09 | Pre-Amp End Zone Card, Type R/S |
| 1 | 06-262-08 | Pre-Amp Center Zone Card, Type R |
| 1 | APL-14-6-5-503 | 50 Amp, 2 Pole Circuit Breaker (Airpax) |
| 1 | APL-1-1-6-2-502 | 5 Amp, 1 Pole Circuit Breaker (Airpax) |
| 1 | APL-1-1-6-2-252 | 25 Amp, 1 Pole Circuit Breaker (Airpax) |
| 1 | M747 | Muffin Fan (Rotron) |
| 1 | 261C 2101 | 0-1500°C. Single Hi-Setpoint Meter Relay (API) |
| 1 | 36N2311 | 120V Indicator, Red (Leecraft) |
| 1 | 41EN-G5-2312 | 28V Indicator, Green (Leecraft) |

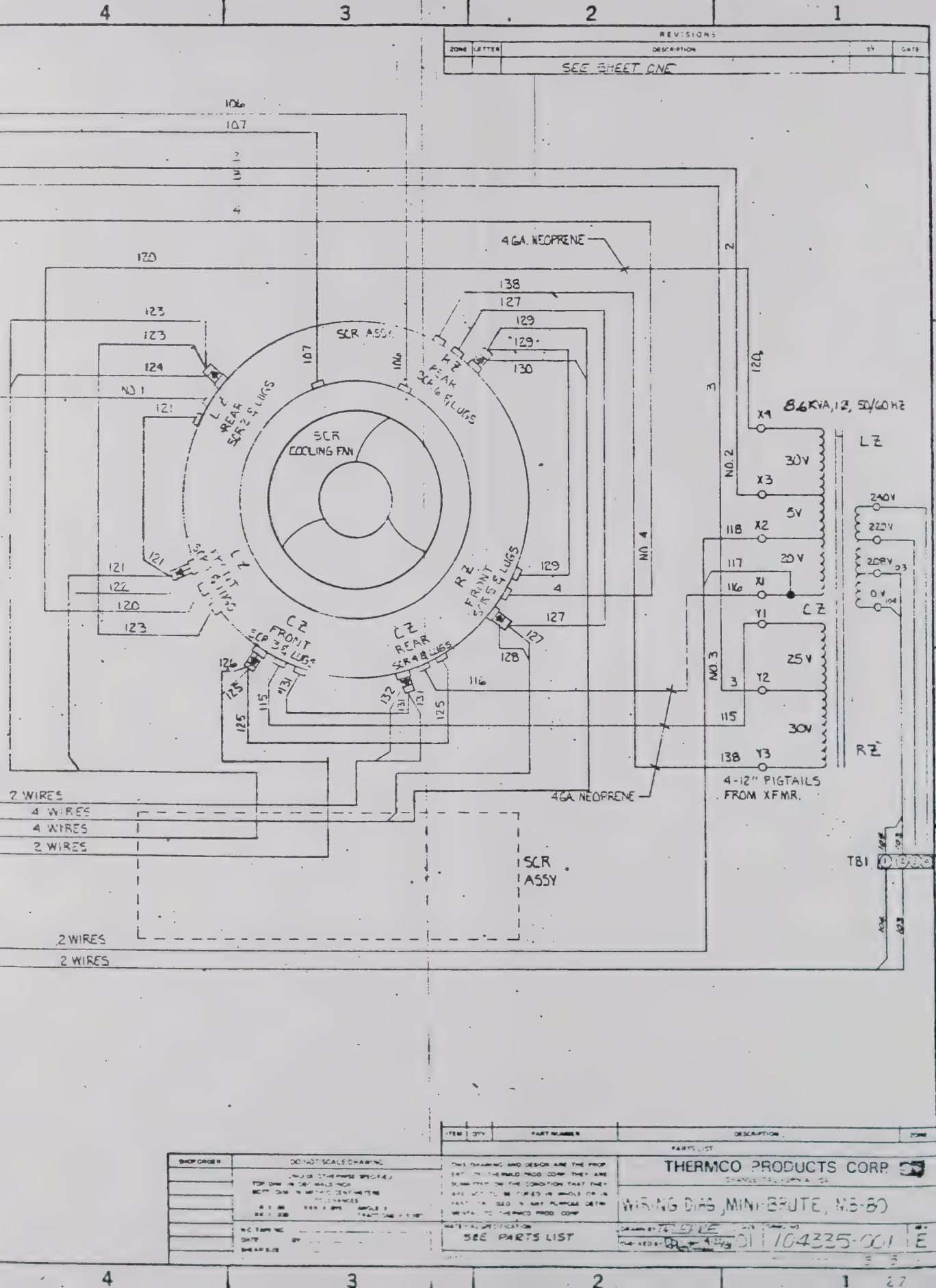
7/2/79

D | 104335-001




NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL WIRE, 22 AWG THHN

8 | 7 | 6 | 5


REVISIONS
ZONE | LETTER | DESCRIPTION | BY | DATE
SEE SHEET ONE
106
107
2
3
4
120
4 GA. NEOPRENE
123
124
NO 1
121
SCR ASSY
SCR COOLING FAN
L Z REAR SCR 2 LUGS
R Z REAR SCR 6 LUGS
C Z FRONT SCR 3 LUGS
C Z REAR SCR 4 LUGS
R Z FRONT SCR 5 LUGS
122
126
125
115
131
132
116
127
128
129
130
138
NO 4
NO 2
NO 3
86 KVA, 12, 50/60 HZ
X4
30 V
X3
5 V
X2
118
20 V
117
X1
116
Y1
25 V
Y2
3
115
30 V
Y3
138
L Z
C Z
R Z
240 V
230 V
208 V
0 V
4-12" PIGTAILS FROM XFMR.
2 WIRES
4 WIRES
4 WIRES
2 WIRES
SCR ASSY
TB1
2 WIRES
2 WIRES
DO NOT SCALE DRAWING
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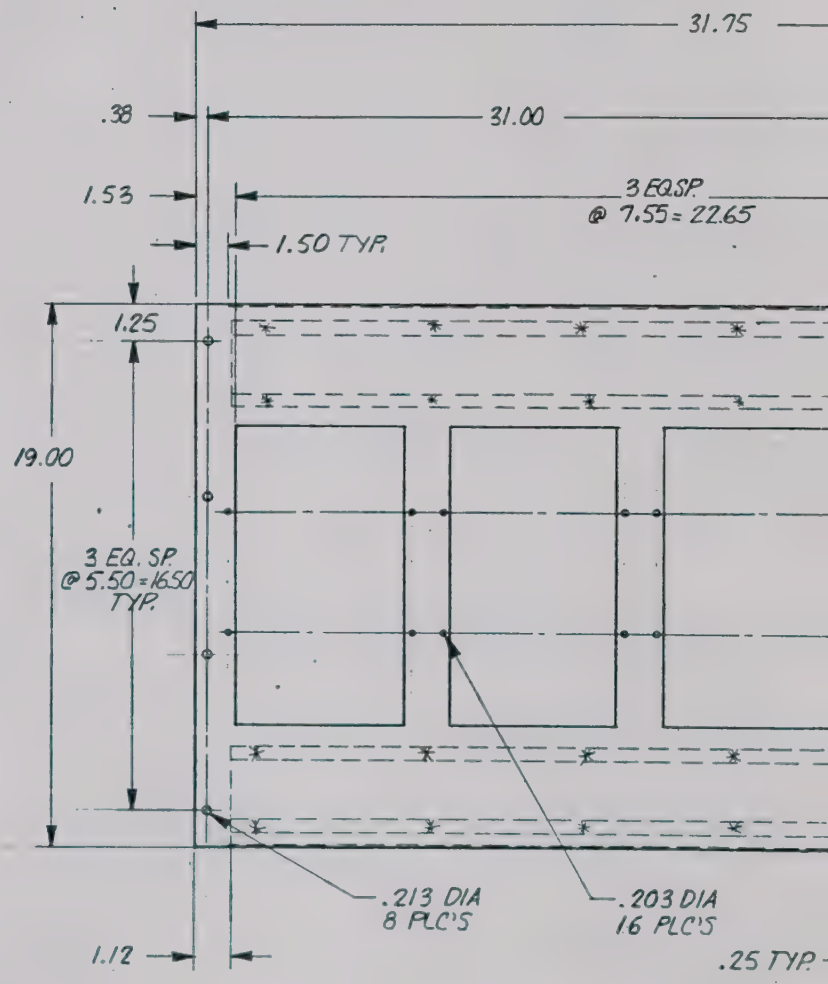
SEE PARTS LIST
THERMCO PRODUCTS CORP.
WIRING DIAG, MINI-BRUTE, M3-60
104335-001
E

| SIZE | DRAWING NUMBER |
| --- | --- |
| C | 101775-001 |




1. BREAK SHARP CORNERS & EDGES.

NOTES: UNLESS OTHERWISE SPECIFIED:

| REVISIONS | | | | |
|---|---|---|---|---|
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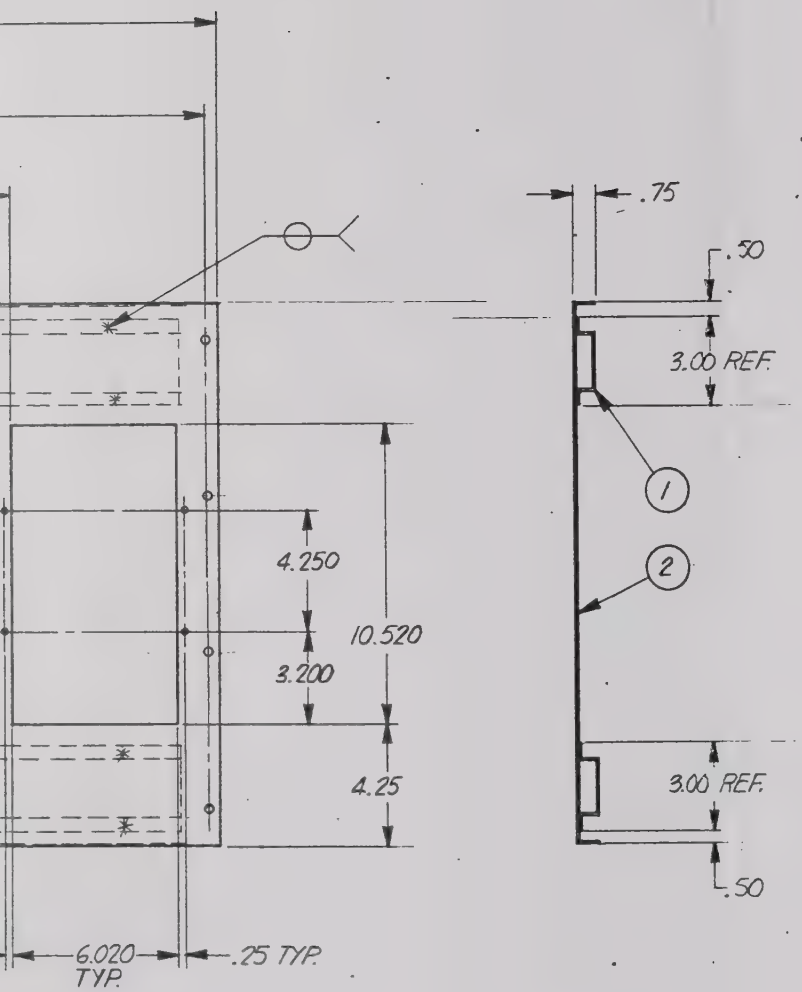
| | A | INITIAL RELEASE | WMP | 6-21-77 |




| ITEM | QTY | PART NUMBER | DESCRIPTION | ZONE |
|---|---|---|---|---|
| 2 | 1 | | CRS - 14 GA | |
| 1 | 2 | 101774-001 | HATSECTION - TIMER PANEL | |

PARTS LIST

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOP DIM. IN DECIMALS/INCH
BOTT. DIM. IN METRIC CENTIMETERS
TOLERANCES
.X ± .06 .XXX ± .015 ANGLE ±
.XX ± .030 FRACTIONS ± 1/16"

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PANEL, TIMER - SOURCE ENCL.

N.C. TAPE NO.
DATE BY
SHEAR SIZE
PIECES MADE

MATERIAL SPECIFICATION

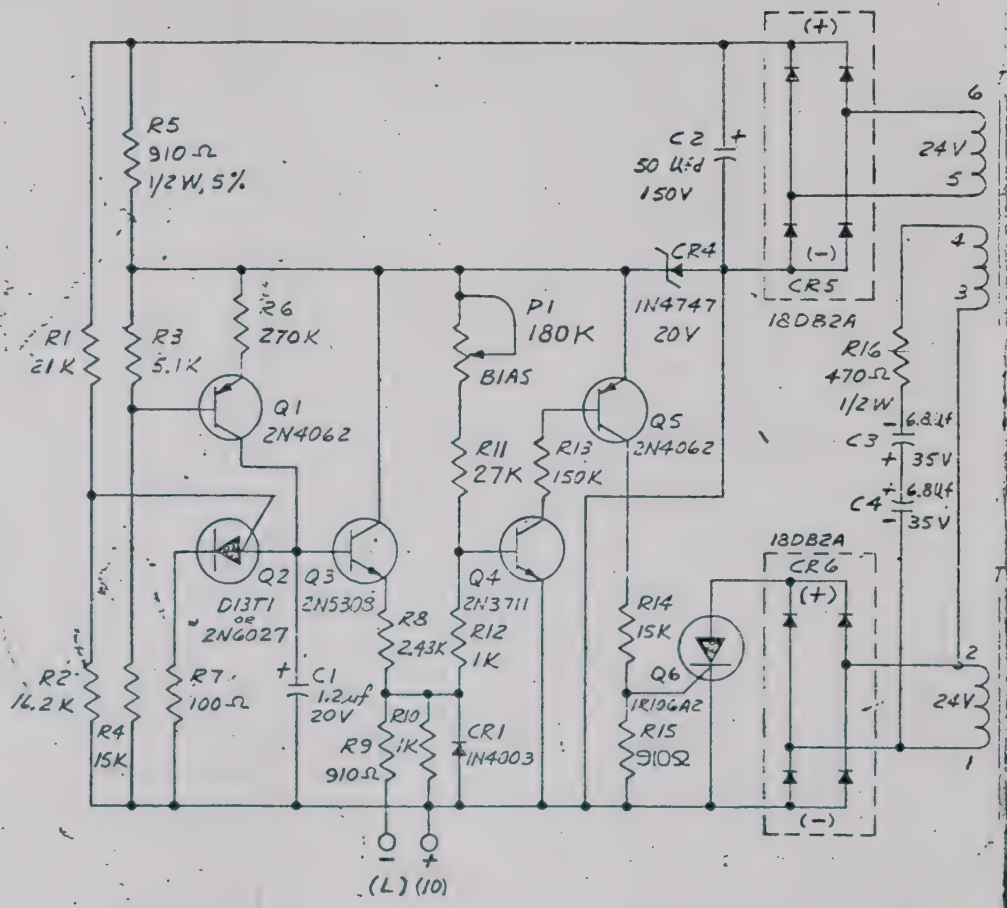
DRAWN BY PARRIS
CHECKED BY ✓
APPROVED BY

SIZE C | DRWG NO 101775-001 | REV A

NEXT ASS'Y

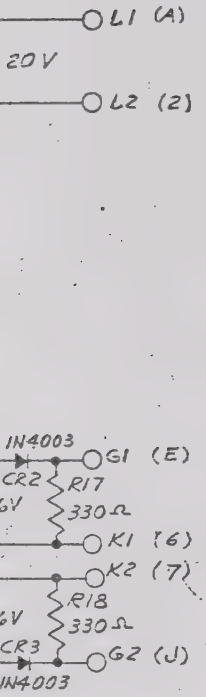
SCALE NONE | SHEET 1 OF 1

10




P.C. CARD ASSEMBLY 15:06-262-42.
1. RESISTORS 1/4 W, 5%. EXCEPT WHEN NOTED.

| | | | |
|---|---|---|---|
| B | R-16 CHANGED FROM 27Ω TO 470Ω PER 10C 5-18-72 | 5-22-72 | EH |
| C | REVISED PER E.C.O 202 | 6-20-72 | [illegible] |
| D | REDRAWN, NO CHANGES. (SEPIA ORIGINAL FROM 06-218-6340) | 8-11-73 | RAR |
| E | REVISED PER ECO 216 | 5-28-74 | [illegible] |
| F | R6 WAS 220K, R6 IS 270K | 9-11-74 | [illegible] |
| G | SEE ECN NO. 2087 | 10-8-75 | M.C.P. |
| H | SEE ECN NO. 2162 | 5-13-76 | [illegible] |
| HI | PRODUCTION RELEASE | 7-19-76 | [illegible] |
| J | SEE ECN 6584 | 12-22-80 | NV |




C (M)

| | | | |
|---|---|---|---|
| S.O. # | N.C. TAPE # | DATE | BY |
| | MAT'L: | SHEAR SIZE = | Pc. |

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| Scale | Drawn By | Checked By | Date |
|---|---|---|---|
| | E.H. | BEST | 2-11-76 |

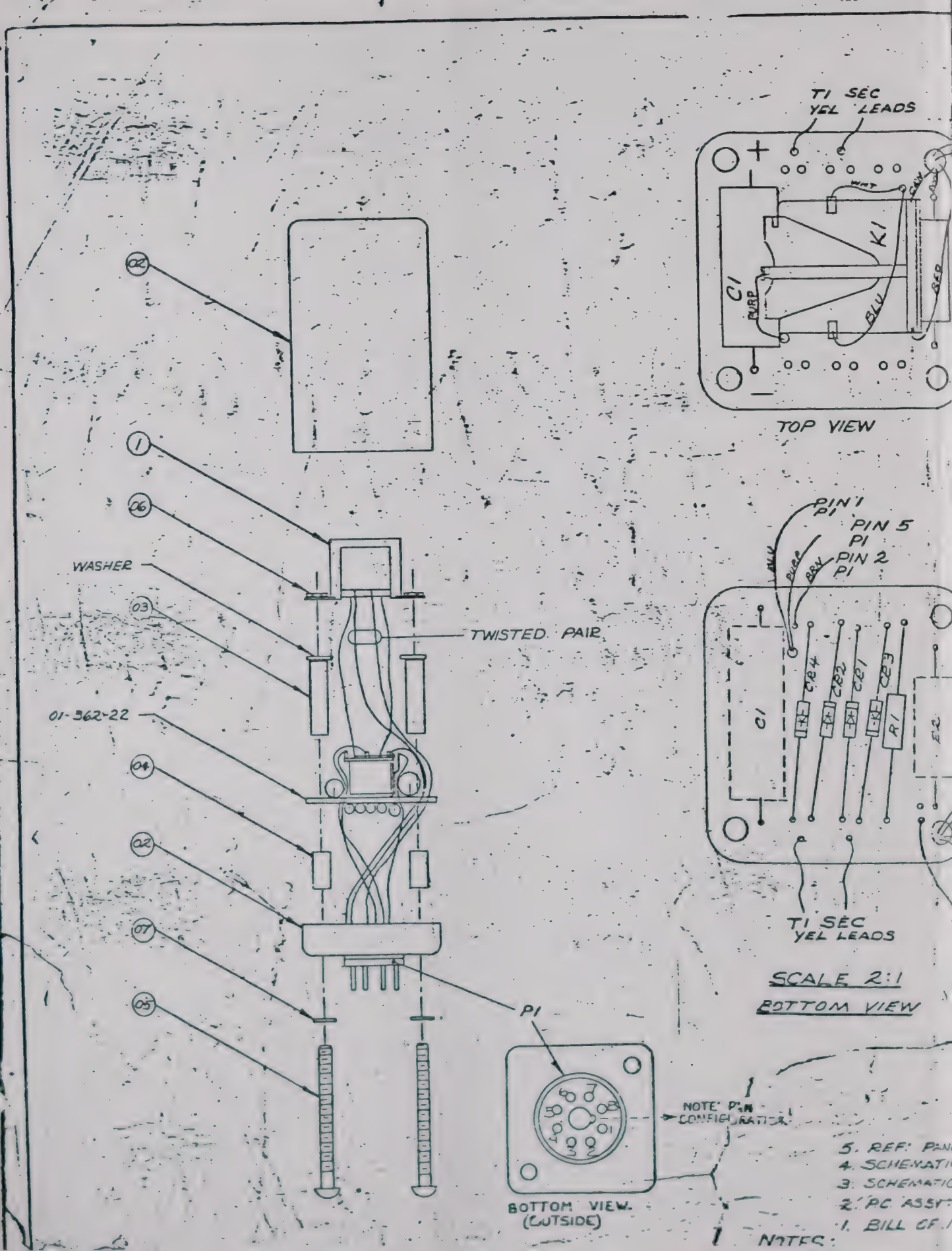
SPECIFIC TITLE: ZERO CROSS-OVER SCHEMATIC

GEN. TITLE: BRUTE INTERNATIONAL

Drawing Number: 06 218 820 J

DO NOT SCALE DWG. | USE TOLERANCES .X ± .050 .XX ± .030 .XXX ± .005 ANG. ± 30'

PRODUCTION RELEASE


T1 SEC YEL LEADS
WHT
GRY
K1
C1
PURP
BLU
RED
TOP VIEW
PIN 1 P1
PIN 5 P1
PIN 2 P1
BLK
PURP
BRN
C1
C84
C82
C81
C83
R1
T1 SEC YEL LEADS
SCALE 2:1
BOTTOM VIEW
02
1
06
WASHER
03
TWISTED PAIR
01-362-22
04
02
07
05
P1
NOTE: PIN CONFIGURATION
BOTTOM VIEW (OUTSIDE)
5. REF: PAN
4. SCHEMATI
3. SCHEMATIC
2. PC ASSY
1. BILL OF
NOTES:

| REV | DESCRIPTION | DATE | BY |
|---|---|---|---|
| F | REDRAWN (WITH NO CHANGES) | 5/3/74 | RCINS |
| G | ADDED BOTTOM VIEW PIN CONFIGURATION | 2-3-76 | RB |
| G1 | SEE ECN 4747 | 4/7/78 | JF |
| G2 | PRODUCTION RELEASE | 7-15-78 | S.E. |
| G3 | SEE ECN 6123 | 2-16-79 | J.W |
| G4 | SEE SHEET 1 of 4 | 8-26-80 | dda |

TI PRI
BLACK LEADS

PINS 3+4
PI BLACK
TWISTED PAIR

RED PIN 6
PI

PIN T
PI

PIN 8
PI

PRODUCTION RELEASE (M)

- 01-212-353
: 01-443-5
: 01-318-803 REF.
01-362-22
AT'L: 01-243-2

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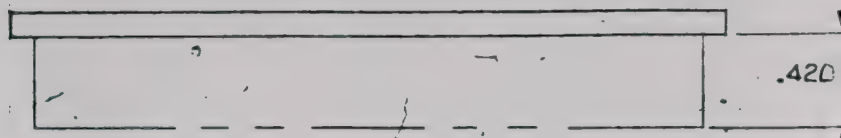
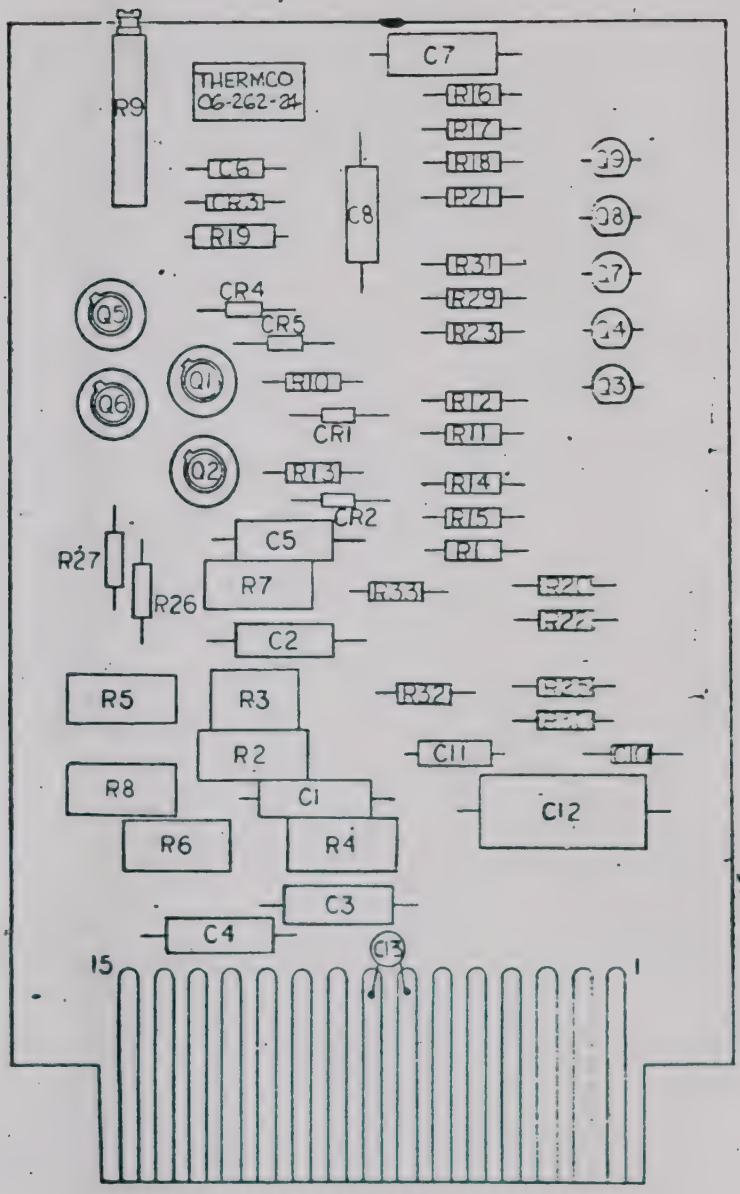
|---|---|---|---|---|---|
| | | D/I - B/M | | | |
| | | Scale NONE | Drawn By R. PERRINS | Checked By | Date 5-8-74 |
| | | SPECIFIC TITLE: ASSY, METER RELAY | | | |
| | | GEN. TITLE: EXCESS. TEMP. | Drawing Number 71243 2 | REV. G4 | |
| | | DO NOT SCALE PRINT | USE TOLERANCES | | 4 of 4 |

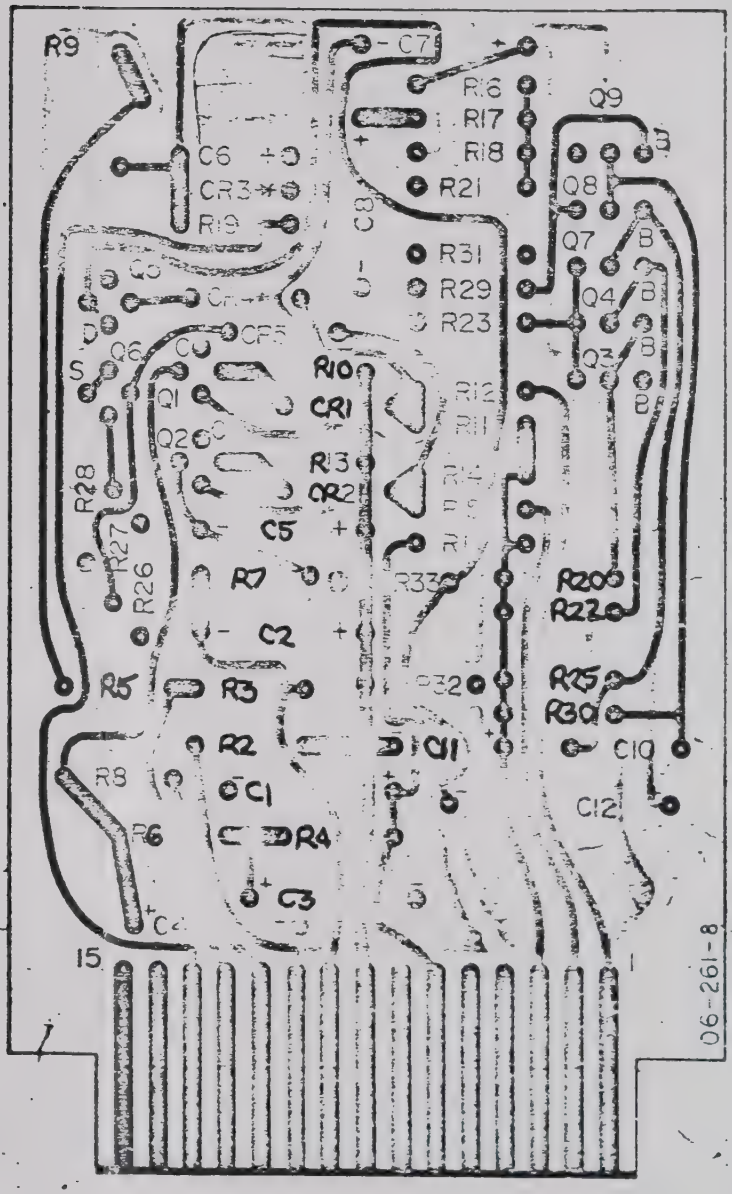



PRODUCTION

REPLACED REF SCHEMATIC 10[illegible]-001
OBSOLETE REF. SCHEMATIC 06-[illegible]-494

| | | | |
|---|---|---|---|
| A | SEE ECN 6310 | 7-5-78 | JC |
| B | CHANGED REF. SCH. NO. & P/N | 8-4-78 | JC |
| BI | PRODUCTION RELEASE | 8-1-78 | E.D. |
| C | SEE ECN 6008 | 9-14-78 | E.D. |
| D | SEE ECN 6007 | 9-25-78 | E.D. |
| DI | SEE ECN 6150 | 5-1-79 | JW |




TYPE R 200°-1200°C

| | | |
|---|---|---|
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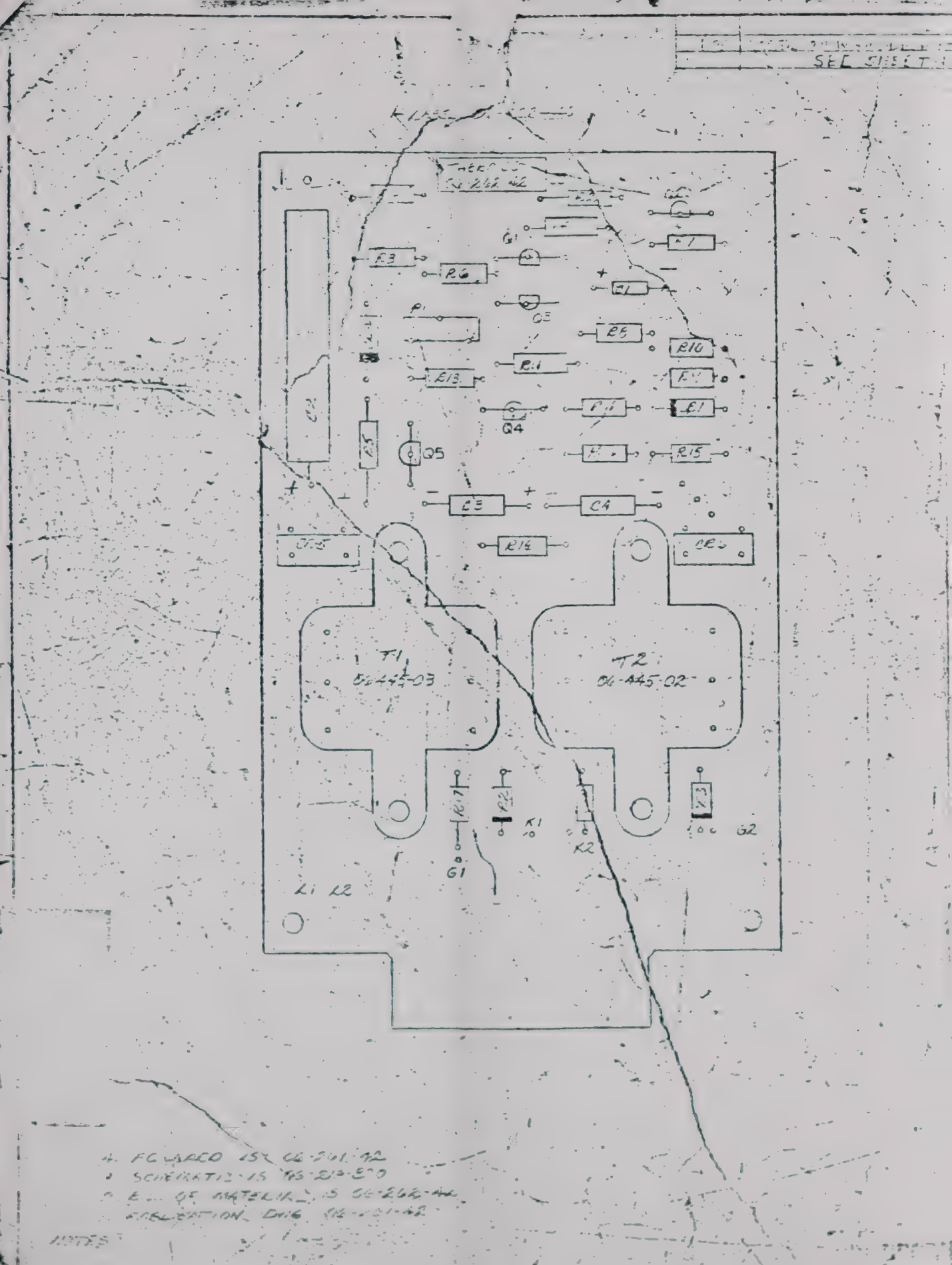
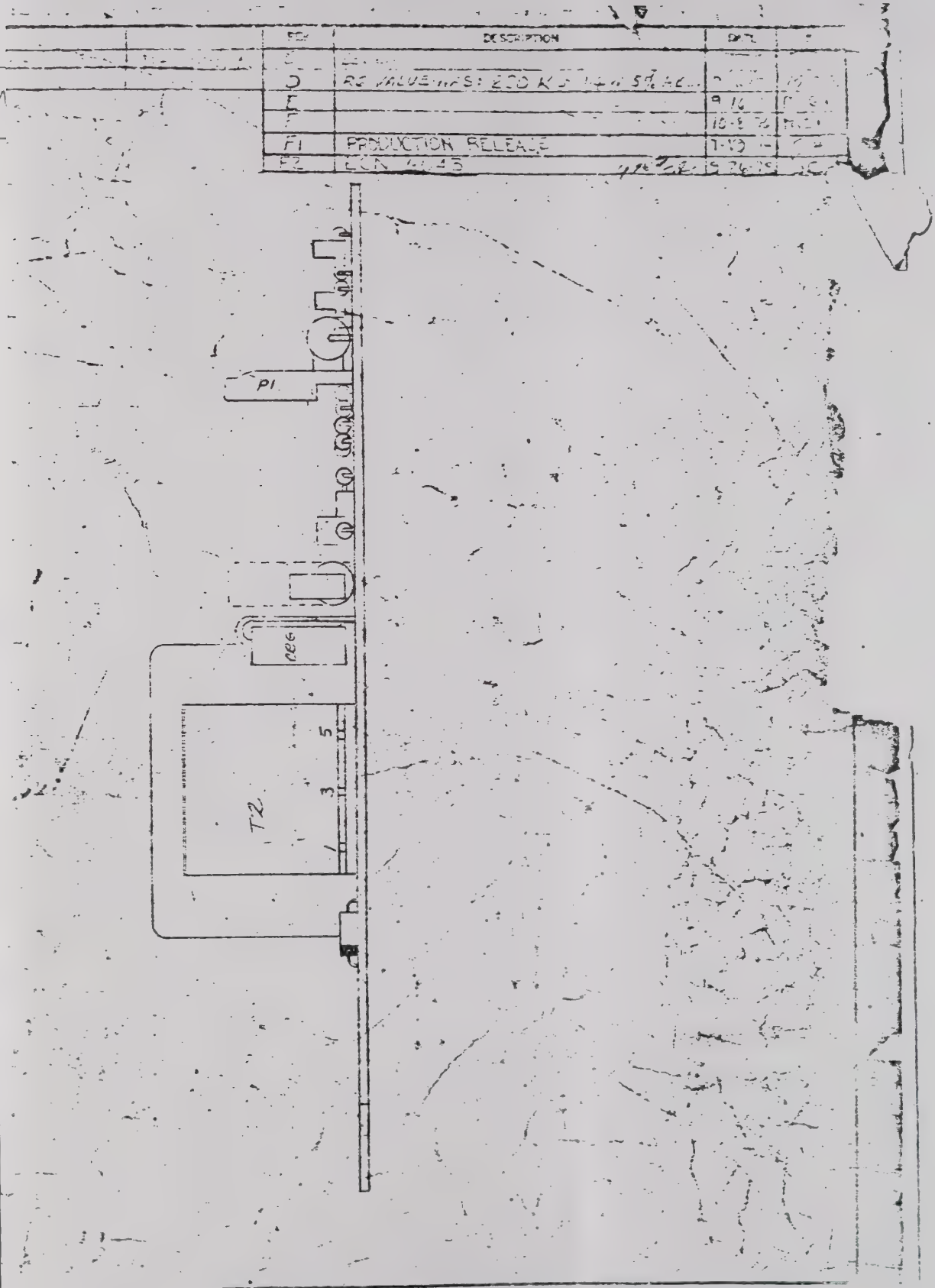
| | DO NOT SCALE DRWG. | USE TOLERANCES |




4. PC BOARD IS SE-201-42
3. SCHEMATIC IS 45-213-500
2. BILL OF MATERIALS IS SE-202-42
FABRICATION DWG SE-201-42

NOTES:

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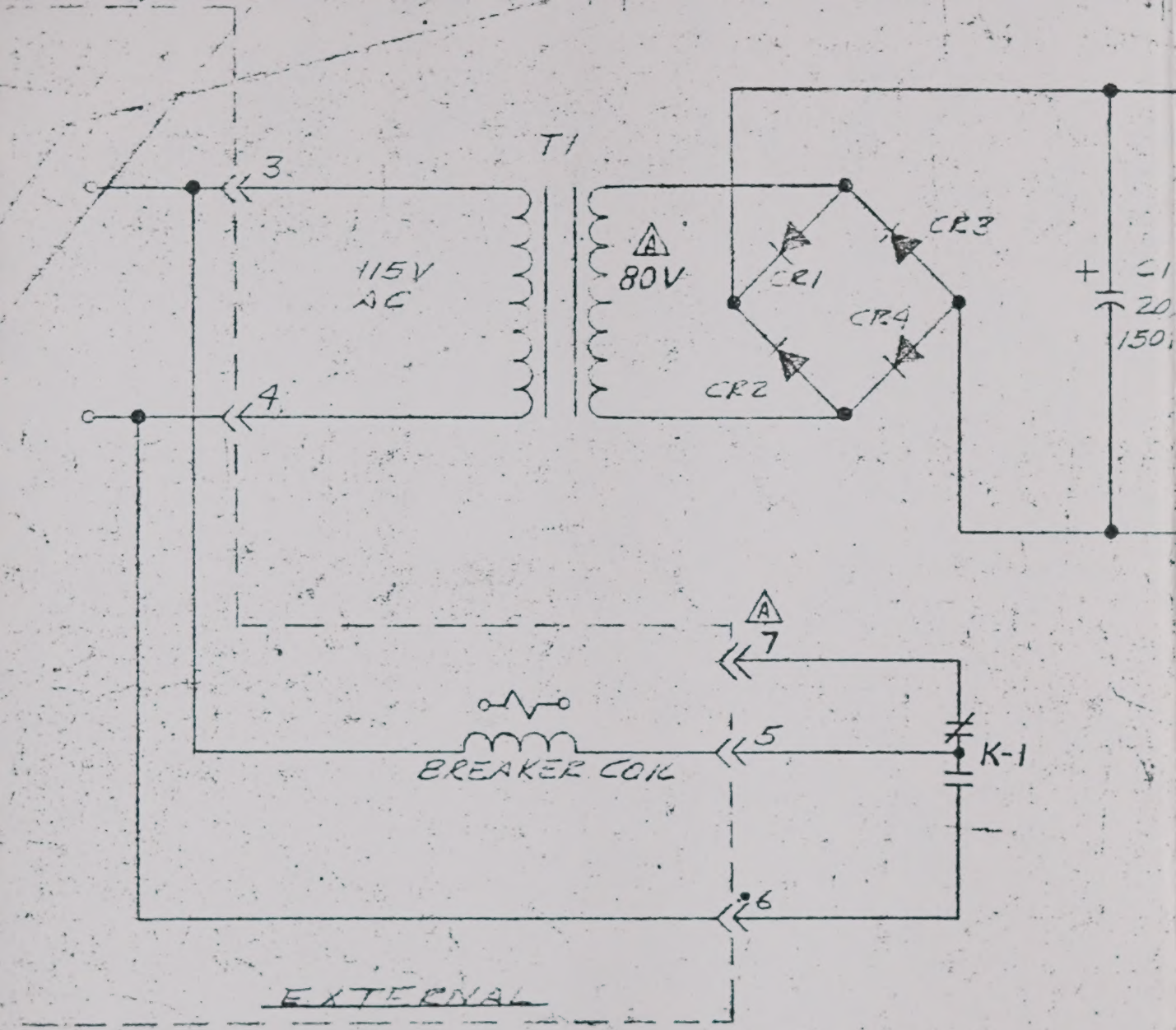
Scale | Checked By | Date

SPECIFIC TITLE

GEN. TITLE

Drawing Number

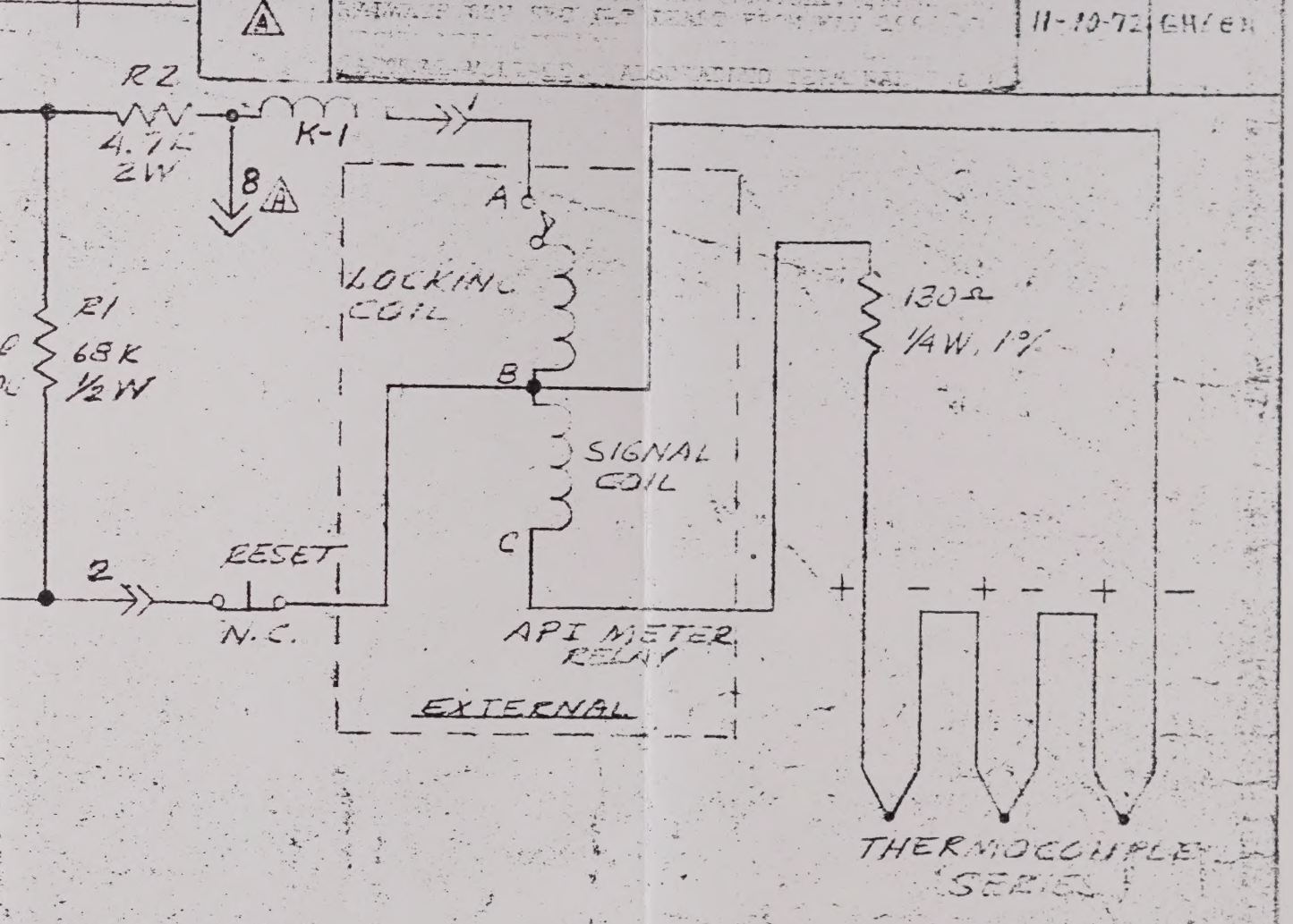



3. SEE SCHEMATIC 01-443-5 FOR D.C. POWER SUPPLY

2. AS

[illegible] 01-243-2

11-10-72 GH/ER




A

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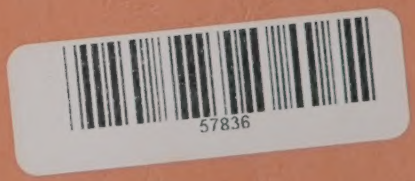
|---|---|---|
| | | Scale: | Drawn By: | Checked By: | Date: 2 SEPT |
| | | SCHEMATIC, METER RELAY |
| | | GEN. TITLE: EXTER | Drawing Number: 01 318 808 B |
| DO NOT SCALE DWG. | USE TOLERANCES | .XX ± .03 | .XXX ± 30' |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